the art as outlined within this Reply, this Reply not including any claim amendments. Notably, this Reply has been filed within the three-month shortened statutory period. Accordingly, neither a petition for an extension of time, nor an extension fee will be required.

Prior to addressing the rejections on the art, the Applicants' herein present a brief review of the Applicants' invention. The Applicants have invented a method and system for distributed agent-based non-expert simulation of manufacturing process behavior. The agents of the present invention are computer programs that perform either or both of information gathering and task processing in an autonomous manner. The agents are given only small, well-defined tasks and behave according to a common communication protocol which allows each agent to query, request, inform and collaborate with other agents in the system. Hence, the agent-based simulation of the present invention can be simple and efficient to configure and operate, requiring only the non-expert provisioning of simulation parameters. By comparison, traditional computer simulation can be complex and cumbersome, requiring expert operators both to program and to operate each computer simulation at substantial cost.

In accordance with the Applicants' invention as illustrated particularly within Figure 1, manufacturing process behavior, such as that exhibited by Push and advanced Lean systems including Pull and Takt systems, can be simulated through the use of distributed agents in single-processor computers. The result of each simulation can be compared to determine which particular manufacturing process would be most appropriate given user-supplied manufacturing parameters, such as intended manufacturing equipment and stack connectivity in the process layout, equipment specification including activity duration, quantity of resources produced and used, initial resource quantities, and a corresponding manufacturing schedule.

The input parameters can be used to perform discrete event simulation. In a discrete event simulation, basic events scheduled to occur during the course of the manufacturing process can occur responsive to which simulation agents forming the manufacturing model can receive notification of such events through a messaging mechanism, for instance a message loop. Each agent can respond to the notification of an event in accordance with pre-programmatic behavior based upon the state of the agent. In that regard, the occurrence of an event, can result in a state change in selected agents forming the manufacturing model. As will be apparent to one skilled in the art through the illustrative object diagram of Figure 3, the agents are loosely coupled so as to respond independently to the occurrence of events without regard to the actions of other agents. Consequently, it can be said that the agents are not tightly coupled in a tiered hierarchy as would be the case in conventional simulation engines.

To achieve the loose coupling of the agent-based simulation of the present invention, a method can be undertaken in which, first, manufacturing technique of choice can be object modeled. More particularly, each process within the manufacturing technique can be identified, and subsequently associated with a distributed programmatic agent. Finally, each programmatic agent can be programmed to respond to the occurrence of discrete events corresponding to the manufacturing technique. Specifically, each discrete event can trigger a programmed response by the agent.

Each agent can be coupled to adjacent agents corresponding, for example, to upstream and downstream manufacturing processes. In that regard, during the course of the agent-based simulation, an agent can receive a message from another agent in the simulation. The agent can identify within the received message a discrete event such as a computerized clock tick event, a resources received event, or a request for output production event. In response, the agent can

cause an associated process to perform an activity. Finally, the agent can message an adjacent agent in response to said identified event.

Claim 1 of the Applicants' invention recites a method for distributed agent based non-expert simulation of manufacturing process behavior on a single-processor computer. The claimed method recites three steps:

> (1) object modeling a manufacturing technique having a plurality of processes;
> (2) associating a distributed agent with each said process; and,
> (3) programming each said agent to respond to discrete events corresponding to said manufacturing technique, wherein each said discrete event triggers a programmed response.

Thus, as broadly claimed, the method can include first constructing an object model of a manufacturing technique formed from a multiplicity of processes. Examples of manufacturing techniques include Push, Pull and Takt techniques. Individual distributed programmatic agents can be associated with each process in the manufacturing technique. Finally, each agent can be programmed to respond to discrete events corresponding to the manufacturing technique. Specifically, each discrete event can trigger a programmed response in the agent.

Claim 8, by comparison, defines a method for distributed agent-based simulation of manufacturing process behavior from the perspective of an individual agent in the system. The claimed method recites four steps:

> (1) receiving a message from an agent;
> (2) identifying in said received message a discrete event selected from the group consisting of a clock tick event, a resources received event, and a request for output production event;
> (3) causing an associated process to perform an activity in response to said identified event; and,
> (4) messaging an adjacent agent in response to said identified event.

As it will be apparent from the explicit language of claim 8, the agent can receive messages from other agents which identify the occurrence of an event. In response to identifying the occurrence

of an event, the agent can undertake pre-programmed processing in addition to messaging other adjacent agents of the identified event. Notably, claim 13 is a computer apparatus construction of the same process.

Importantly, as reflected in each of the independent claims 1, 8 and 13, the use of an agent-based simulation provides an effective method to model several disparate manufacturing techniques so as to enable an intelligent comparison of the performance of each manufacturing technique based upon a set of supplied parameters. To achieve the same result using a conventional expert simulation would require either complex programming, or the use of individually distinct simulation systems. In either case, substantial configuration must be performed by expert personnel familiar with expert simulation. In the Applicants' invention, however, an operator need not have an expert understanding of simulation software and simply can provide manufacturing parameters to initiate the agent-based simulation.

Turning now to the cited art, Lin relates to a multi-agent information system approach to modeling a product order fulfillment process (OFP) in a supply chain network (SCN). Unlike the manufacturing processes described in the Applicants' patent application, an OFP begins first with the receipt of an order from a customer and ends with the delivery of the finished good to the customer. A manufacturing process, including production scheduling, material planning, capacity planning and shop floor control, can be included, however, as part of the OFP.

Notably, Lin directly relates to the SCN recognizing that contemporary manufacturing practices have shifted to an "out-sourcing" paradigm. In response, the multi-agent information system of Lin is directed to optimizing the relationships between multiple business entities in the SCN. Specifically, the multi-agent information system of Lin can include four components: agents, tasks, organizations and information infrastructure. Importantly, in Section 4 of Lin, an

agent is defined as "an active object which possesses certain capabilities to perform tasks, and communicates with other agents based on the organizational structure to cooperate with the accomplishment of tasks". Tasks, by comparison, are defined as "things which agents are assigned to work on."

Notably, referring to Figure 3 of Lin, two types of agents are provided in the multi-agent information system, namely "physical agents" and "logical" or "functional" agents. Physical agents represent physical objects such as factories, production lines, machines and corporate. Logical agents, by comparison, represent MRP systems, order entry systems, and production control systems. Significantly, neither the physical agents, nor the logical agents, represent a manufacturing process within a manufacturing technique. Rather, aspects of manufacturing, are handled at the macro level, as described in Section 5 of Lin, and include an "Order Management Agent", an "Inventory Management Agent", a "Production Planning Agent", and a "Capacity Planning Agent". Consequently, the agents of Lin cannot be used to compare the results of different manufacturing techniques. Of course, it is not the intent of Lin to do as much. Rather, the explicitly stated intent of Lin is to optimize an SCN in the course of an OFP.

Importantly, the multi-agent information system alone cannot model an SCN. Rather, a separate simulation system, referred to in Lin as the "Swarm Simulation System" can be utilized by the multi-agent information system both "for enterprise integration modeling", and "illustrating electronic virtual organization management". In that regard, and unlike Applicants' agent-based simulation process, however, the Swarm Simulation System has a "Nested inherent hierarchy" as taught in Tables 1 and 2 of Sections 4 and 5 of Lin. Thus, the Swarm Simulation System cannot enjoy the advantages of the loosely coupled, autonomous agents of the Applicants' claimed agent-based simulation system.

Turning now to the rejection on the art, the Examiner has rejected each of claims 1 through 17 as being anticipated by Lin. In support of these rejections, the Examiner contends that Lin teaches the following:

(1) An agent based manufacturing simulation.

(2) The modeling of a manufacturing technique via agents. NON SPECIFIC-

(3) The programming of an agent to respond to manufacturing events and to trigger responses.

The Applicants respectfully disagree with these contentions as follows. First, nowhere in Lin is it disclosed or suggested that agents are used to perform a simulation of the manufacturing process. Rather, in Section 5 of Lin it is explicitly stated that the multi-agent information system in conjunction with the Swarm Simulation System "acts as a *modeling tool* to represent the business entities as agents and the involved information and material flows for the OFP in SCNs". Thus, Lin teaches the modeling of an entire order fulfillment process of which manufacturing enjoys a discrete role. Lin fails to teach the modeling of the manufacturing in the OFP, however, and as a result, it cannot be said that Lin performs a simulation of a manufacturing process in which a combination of business entities have no active role.

Second, Lin fails both to teach and to disclose or suggest any one manufacturing technique of which a simulation or modeling analysis can be performed. To that end, Lin relates exclusively to the aggregate process of order fulfillment in a supply chain network. Any treatment of manufacturing is taken at the macro-level and no "manufacturing processes" are simulated or modeled. Specifically, Table 2 of Lin specifically equates agents to individual "semi-autonomous business entities" and not to individual processes in a manufacturing technique as explicitly recited in the Applicants' claims 1, 8 and 13. In consequence, the Lin

teachings cannot be used to compare one manufacturing technique with another, such as a Push system to a Takt system, or a Pull system to a Takt system.

Third, Lin does not suggest the responsiveness of agents to manufacturing events. Specifically, in the Applicants' specification, manufacturing events are defined to include as an example, clock tick messages, a resources received message, and a request for output production message. Accordingly, events are not to be confused with tasks. Rather, as stated in Section 5 of Lin, tasks are considered to be "things which agents are assigned to work on". Thus, as Lin lacks each of these critically claimed elements of the Applicants' independent and dependent claims 2 through 7, 9 through 12, and 14 through 17, Lin does not anticipate or render obvious Applicants' claimed invention.

Finally, it should be clarified that the stack operations included within claims 3 through 7, 9 through 12, and 14 through 17 relate not strictly to the stack data structure. Rather, as defined in page 11 of the Applicants' specification, "each process object can include an input stack for receiving resources from a downstream process object, and an output stack for depositing output, formed from received resources." The input stack and output stack need not be programmatically defined using a stack data structure, however, and any suitable data structure can suffice, including a basic array, linked list, queue, etc. Accordingly, the Applicants respectfully disagree that the use of an input and output stack as recited in the claim language of the Applicants' patent application is an "obvious well known computer programming technique".

Based on this Reply, Applicants have presented claims which distinguish over the cited art, and it is believed that all claims are now in condition for allowance. Thus, Applicants submit that their claimed invention is not disclosed or suggested by any art. Therefore, Applicants

respectfully request reconsideration and allowance of all pending claims. Please feel free to call the undersigned if any questions regarding this case arise.

Respectfully submitted,

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